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## (54) Device for carrying out an electrolytic process.

(57) A device for electrolysing a chloride, in which several electrolytic cells consisting of electrodes (3, 4) and a diaphragm (22) are electrically connected in series, whereby each cell is provided with a supply line and a discharge line for electrolyte, and a discharge line for the gas developed, said cells being surrounded by an encasing having two plates (1, 2) on end, and whereby a fluid jacket (7a, 7b, 7c), provided with a supply line (14) and a discharge line (15) for fluid, is disposed between the encasing and the outside of the cell frames, said fluid being a liquid and said de-aeration tubes (8) for separating and discharging chlorine gas and hydrogen being disposed in said fluid jacket, said electrodes being combined to form bi-polar electrodes (6).

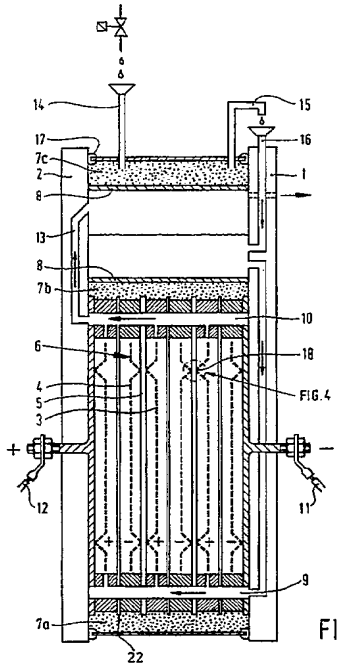


FIG.1

FIG.4

EP 0 427 340 A1

# A DEVICE FOR CARRYING OUT AN ELECTROLYTIC PROCESS.

The invention relates to a device for electrolysing a chloride, in which several electrolytic cells consisting of electrodes and a diaphragm are electrically connected in series, whereby each cell is provided with a supply line and a discharge line for electrolyte, and a discharge line for the gas developed, said cells being surrounded by an encasing having two plates on end, and whereby a fluid jacket, provided with a supply line and a discharge line for fluid, is disposed between the encasing and the outside of the cell frames.

This device for carrying out an electrolytic process is known from German Patent Specification No. 396,221 (1924). In this device for carrying out an electrolytic process electrolyte is prevented from leaking out of the cell by providing a gas shield around the electrodes, in which gas shield a gas is kept under an elevated pressure. The pressure inside the cell is lower than outside the cell, which, due to the absence of cell sealings, results in gas leaking in. With the device according to said German Patent Specification there is still a risk that gas formed during the electrolytic process (such as chlorine gas) escapes, because the electrolytic cells are screened, the separators and the connecting conduits, however, are located outside the protective jacket.

From Dutch Patent Application No. 7213157 there is known a multiple electrolytic cell having a diaphragm, which contains bi-polar electrodes. From EP-A-216,413 there is furthermore known a device for carrying out an electrolytic process, whereby a disinfectant for water is prepared by electrolysing an aqueous NaCl-containing solution, whereby NaCl, residual brine and H2, but no free Cl2 is obtained. Said device consists of series-connected bi-polar electrodes. In the anode and cathode spaces of said cells openings are provided for supplying anolyte. Also there are provided supply lines for the saline solution and for collecting hydrogen. Furthermore there are provided passages for collecting anolyt. However said passages do not provide a sealing of the electrolytic cell, which may result in leakages or necessitate the use of seals. Figure 2 of EP-A-216,413 illustrates a hydrogen separator (31, 32) present outside the cell.

A drawback of the existing electrolysis equipment, in which several bi-polar electrodes are connected in series, forming a so-called filter press-type cell, is that a great deal of attention must be paid to properly sealing the cells, so that no electrolyte will leak from the electrolytic cell. Although the aforesaid Dutch Patent Application No. 7213157 does not pay much attention to such seals, it does mention that the tightness is obtained by way of sealing means (not shown) present between the individual elements, such as metal electrodes, frames and diaphragms. In EP-A- 55,931 and 280,359, and in US-A- 4,344,633 special attention is paid to such seals. This seal is in particular important because the electrolytic process leads to chemically agrressive substances being formed, which are highly corrosive with respect to the area around the cell. Such seals make the electrolytic cells costly, and their production is only possible by using labour-intensive methods. 'Furthermore it has become apparent that the seals used up to now develop leakages, especially after some time has lapsed. Furthermore, as a result of different seals being used, it is problematic or costly to secure the electrodes flat in the frames. Another drawback of the seals to be used is that they are often the determining factor with regard to the distance between the electrodes; a larger distance between the electrodes often results in a reduced current efficiency.

This problem with regard to the seals to be used with electrolytic cells is now solved by using a device according to the invention as mentioned in the preamble, and said device is characterized in that said fluid is a liquid, and that said de-aeration tubes for separating and discharging chlorine gas and hydrogen are disposed in the fluid jacket, and that the electrodes are combined to form bi-polar electrodes. Thus a fluid jacket is provided within the encasing of the device, around the system of the cell frames having bi-polar electrodes, said fluid preferably being water, so that a possible leak from the electrolytic cells is allowable, because any fluid that leaks out is collected in the water jacket, which is periodically or continuously changed. A slight inleakage of water is acceptable thereby. In the de-aeration tubes or separators the electrolyte and the gas which has formed are separated, so that hydrogen and chlorine gas from said de-aeration tubes can readily be recovered. The construction of the de-aeration tubes and the supply line for electrolyte and gas to said de-aeration tubes will be explained in more detail hereinafter. Although the following part of the present description relates to such a preferred electrolytic process for preparing chlorine gas, it will be apparent that also other electrolytic processes may be carried out in such a device. The development of chlorine gas in particular for purifying swimming water in swimming pools is receiving a lot of attention, because when the chlorine gas which has been developed is used, it is not necessary to use chlorine bleaching lye or the like. The device according to the invention can

also be used, however, to prevent the occurrence of algal growth in cooling towers, to pasteurize milk or icecream, which may also be done by means of UV-light, and in general in those places where germs and the like are killed.

Because with the construction according to the invention less attention, if any, needs to be paid to the sealing material and the required pressures, which are exerted on the cell frames in which the bi-polar electrodes are placed, it is now possible to use specific bi-polar electrodes which are secured between the cell frames. Said bi-polar electrodes according to the invention consist of an anode plate, a cathode plate, and a centre wall located therebetween. Ridges are pressed in the electrode plates, which bottom sides form a welded joint between the electrodes and the centre plate. Preferably the anode weld and the cathode weld lie in one plane thereby, extending perpendicularly to the centre wall, so that no weldings stresses are set up, which might cause the plates to become warped. Bi-polar electrodes in general are known from Dutch Patent Application 7808691, which discloses bi-polar electrodes provided with spacers between the anode plate and the cathode plate. From said Dutch Patent Application it appears how important it is that a constant distance is maintained between the anode plate and the cathode plate and the centre wall, and that costly measures must be taken with the known bi-polar electrodes in order to obtain properly operating bi-polar electrodes. According to the invention it has now become possible to obtain inexpensive constructions for bi-polar electrodes, whereby it has been ensured that the bi-polar electrodes are permanently flat and that the distance between the anode plate and the cathode plate of the bi-polar electrode is as small as possible.

The invention will be further explained with reference to the following description, wherein reference is made to the appended drawing, in which:

Figure 1 a sectional view of a device according to the invention, consisting of several electrolytic cells having bi-polar electrodes;

Figure 2 is a perspective view of the construction of such a device;

Figure 3 is a perspective view of the de-aeration tube, whereby the supply line for electrolyte opens into said tube; and

Figure 4 shows a detail of the bi-polar electrode, in particular of the location of the welded joint between the electrodes and the centre plate.

In Figure 1 a sectional view of the device according to the invention is shown, said device consisting of an encasing having two plates 1 and 2 on end, said encasing being provided with a current supply lead 12 and a current discharge lead 11, between which there are provided several electrolytic cells, one cell consisting of a bi-polar electrode 6 being illustrated in more detail. Said bi-polar electrode 6, illustrated in detail in Figure 4, consists of a cathode 4 and an anode 3, both being welded on a centre plate 5. Both electrodes 3 and 4 have been provided with ridges, indicated by 18, which ridges have been welded at the lower side in the centre plate 5. Since welding, especially when spot-weldings 19 are being used, can be done very accurately, a flat bi-polar electrode is obtained with a constant distribution of current across the entire electrodes 3 and 4 during operation. The electrolytic cells are provided with a supply line for electrolyte 9 and a discharge line 10 for said electrolyte, said discharge line 10 opening into a riser pipe 13, which opens into the de-aerator 8. The electrolyte which is discharged at 10 and 13 comprises the gas formed in the electrolytic process, which gas may e.g. be hydrogen or chlorine released from the fluid carried along in the de-aerator 8. A foamy product is therefore introduced into the de-aerator via the conduit 13, which product is separated into a fluid and a gas in the de-aerator. This is explained in more detail with reference to Figure 3.

In order to prevent the occurrence of leakages from the electrolytic cells in the known device the bi-polar electrodes are encased in seals. In the embodiment illustrated in Figure 1, however, a greater tolerance is possible when the electrodes are placed between frames, because any leaking electrolyte is collected in the water jacket 7a, 7b and 7c. The device according to the invention is at its upper side provided with a water dosaging device 14 and with a water discharge line 15, which opens into the electrolyte that is supplied to the cell via the conduit 16. Thus the water, which functions to catch any leaking electrolyte, can be used in the cell as the fluid to be electrolysed. Because the corrosivity of the fluid in the water jacket is only very small, because the electrolyte or electrolytic product that may be present is highly diluted, the encasing may be provided with seals which do not have to meet the same stringent demands as the known cells mentioned above. Said seals are used at the joint between the horizontal encasing parts and the plates on end. For this purpose a simple rubber seal may be used, as is indicated at 17 in the drawing. By providing the conduit (separator) within the fluid jacket, any risk with regard to gases (e.g. chlorine) leaking out is eliminated.

Figure 2 is a diagrammatic perspective view of the construction of the device according to the invention, the core of the electrolytic cell being formed by the bi-polar electrode 6, which consists of a centre plate 5 on which the cathode 4 and the anode 3 are provided. The cathode 4 is shown to

have ridges 18, the bottom sides of the ridges are welded on the centre plate 5. The bi-polar electrodes are secured between the cell frames. In Figure 2 the bi-polar electrode 6 is secured between the cell frames 20 and 21. The various bi-polar electrodes are mutually separated by means of the diaphragms 22 and 22a. The cathode and the anode are preferably made of a gauze or a perforated metal plate.

The parts mentioned, viz. the bi-polar electrode 6, secured between the cell frames 20 and 21, and the diaphragms 22 and 22a, are provided with holes 23 - 26, said holes 23 - 26 constituting the passages for the electrolyte. The openings 24 and 25 open into the discharge tubes 13 and 13a for the electrolyte, said discharge lines from the conduits 13 and 13a in turn opening into the de-aeration tubes 8 and 8a. In said de-aeration tubes fluid and gas are separated, as is illustrated in Figure 3. A de-aerator is as such known from EP-A- 43,945.

As a result of the gas evolution in the electrolytic cell a foamy mixture is produced, which as a result of the reduction of the specific weight is pushed upwards and thus arrives in the conduits 13 and 13a. Thus the foamy mixture consisting of fluid and gas is pushed into the de-aeration tube with great force, in which tube, as a result of the presence of the supply line 13 in the de-aerator 8, (see figure 3) a centrifugal force is exerted on the foamy product, resulting in the fluid and the gas being separated, whereby the fluid is discharged as an electrolyte near the discharge end and the gas can be recovered from the de-aerator.

Thus e.g. chlorine gas can be efficiently obtained by means of an electrolytic process, whereby the electrolytic cell has been improved considerably with respect to the known cells, to the effect that no costly seals need to be used, and that the bi-polar electrode can be formed in an efficient manner.

## Claims

1. A device for electrolysing a chloride, in which several electrolytic cells consisting of electrodes and a diaphragm are electrically connected in series, whereby each cell is provided with a supply line and a discharge line for electrolyte, and a discharge line for the gas developed, said cells being surrounded by an encasing having two plates on end, and whereby a fluid jacket, provided with a supply line and a discharge line for fluid, is disposed between the encasing and the outside of the cell frames, characterized in that said fluid is a liquid, and that said de-aeration tubes for separating and discharging chlorine gas and hydrogen are disposed in the liquid comprising jacket, and that the electrodes are combined to form bi-polar electrodes.

2. A device according to claim 1, characterized in that' said liquid in the jacket is water.

3. A device according to claims 1 - 2, characterized in that said de-aeration tubes are secured between said plates on end.

4. A device according to claims 1 - 3, characterized in that conduits present near or in said plate on end provide connections between the discharge line for electrolytes from the cell pack and the supply line for electrolytes to the de-aeration tubes.

5. A device according to claim 4, characterized in that the supply line for electrolytes from the cells to the de-aeration tubes is arranged such that the electrolytes can be supplied tangentially and axially.

6. A device according to claim 1, characterized in that said electrodes are bi-polar electrodes, which are secured between cell frames.

7. A device according to claim 6, wherein said bi-polar electrode consists of an anode plate, a cathode plate, and a centre wall located therebetween, said centre wall being connected to said anode as well as to said cathode, characterized in that longitudinal ridges ace pressed in the cathode and in the anode, said ridges at their bottom side being welded on the centre wall, whereby the cathode and the anode are welded on the centre wall in opposed relationship.

8. A device according to claim 7, characterized in that said anode and said cathode are made of a gauze or a perforated metal plate.

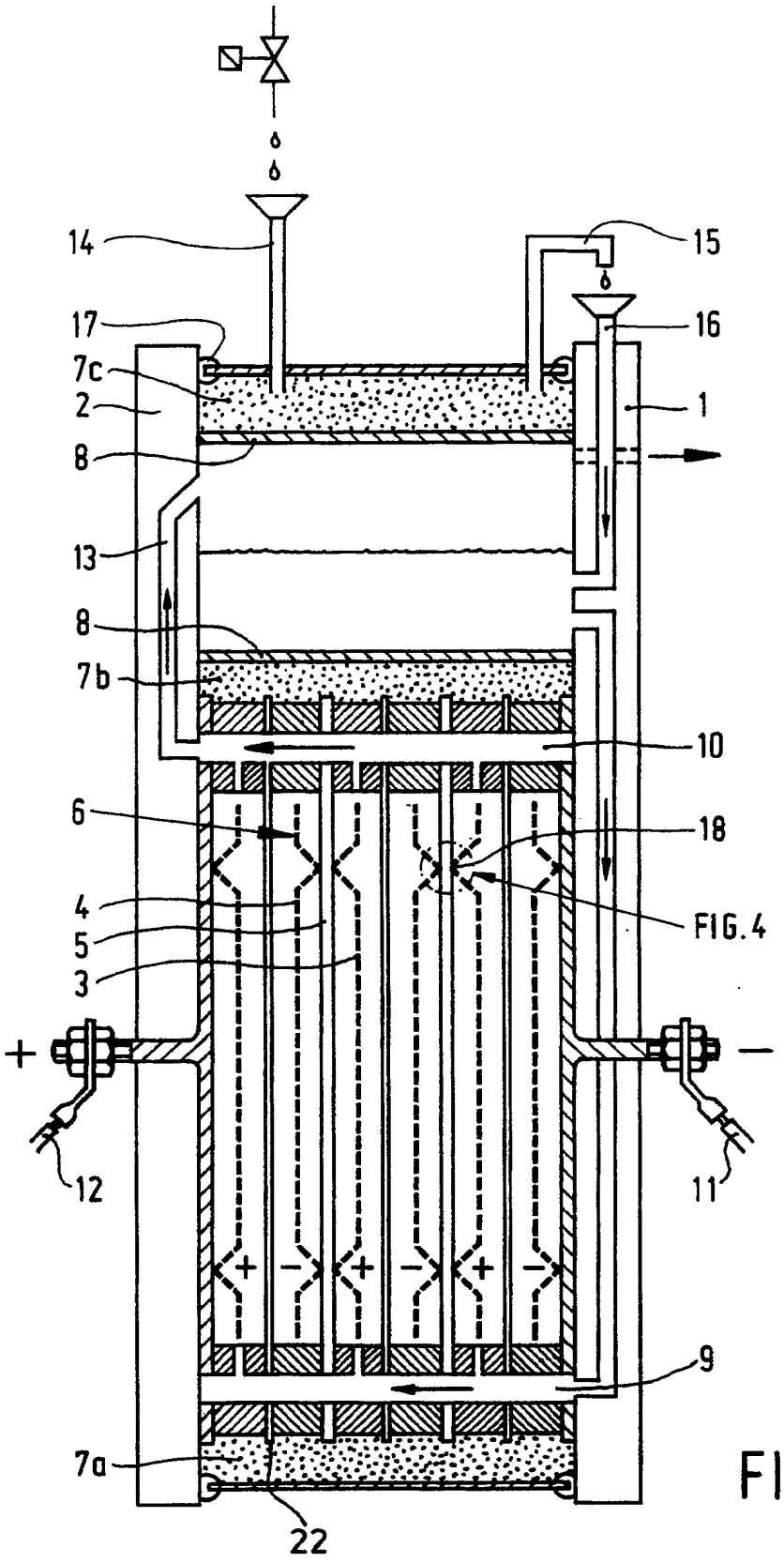


FIG.1

FIG.4

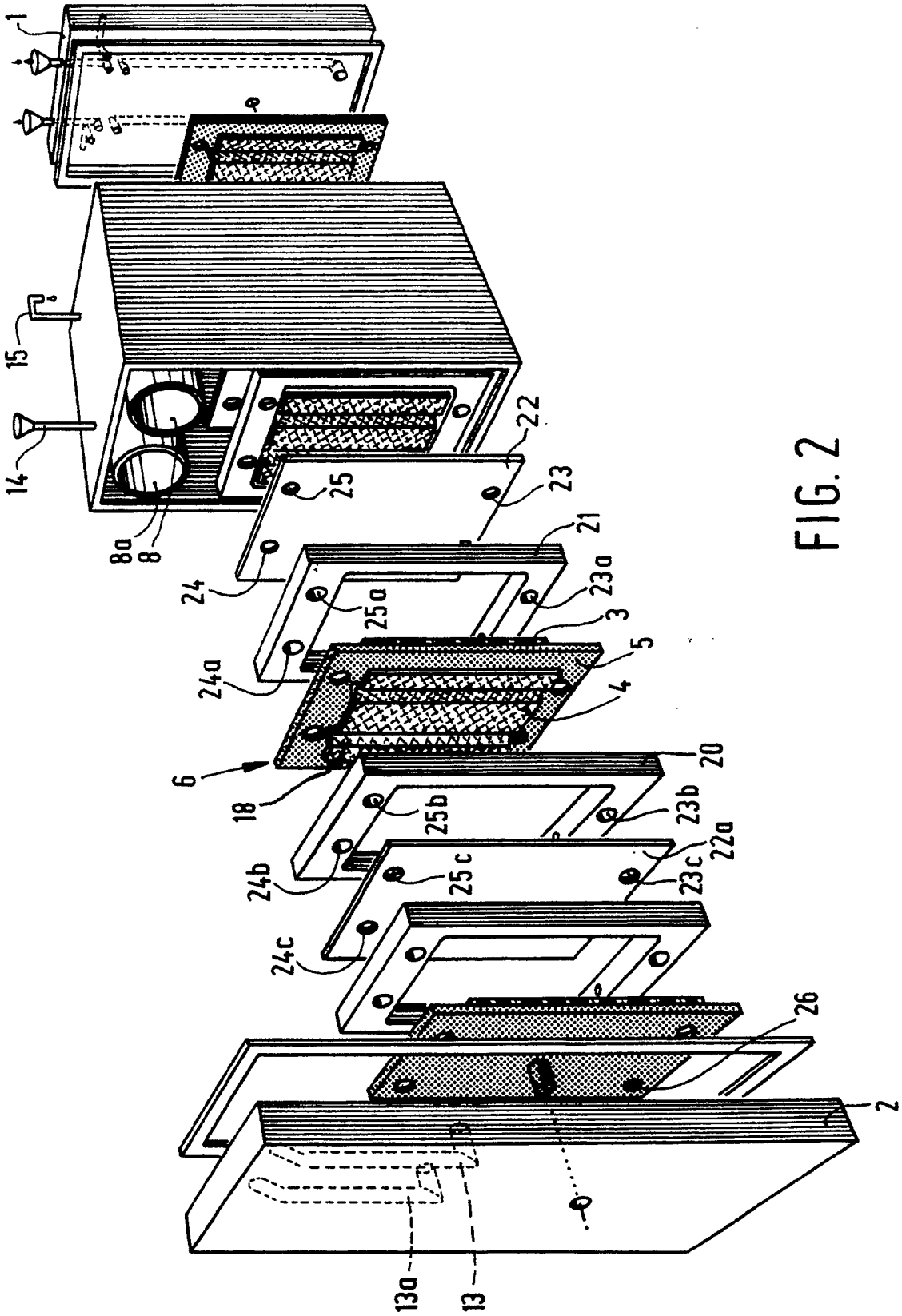
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FIG. 2

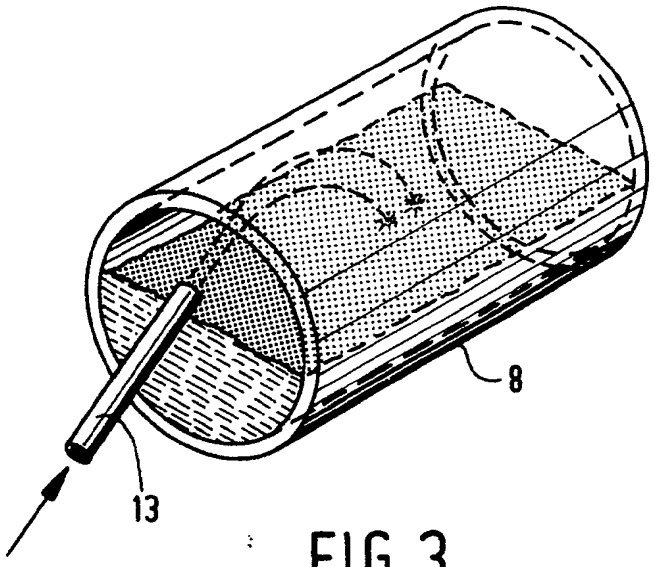


FIG. 3

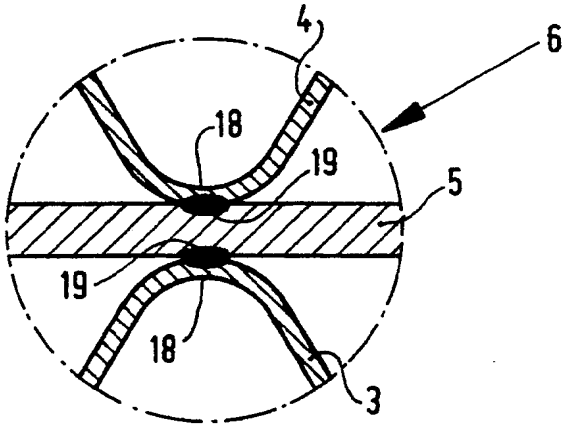


FIG. 4

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# EUROPEAN SEARCH REPORT

Application Number

EP 90 20 2926

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int. Cl.5) |
|---|---|---|---|
| D,A | DE-C-3 962 21 (Dr. BODO HAAK)<br>* Whole document * | 1 | C<br>25 B 9/00 |
| A | PATENT ABSTRACTS OF JAPAN, vol. 3, no. 27 (C-39), 7th March 1979;<br>& JP-A-54 2978 (ASAHI GLASS K.K.) 10-01-1979<br>* Abstract * | 1 | |

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

C 25 B 9

The present search report has been drawn up for all claims

| Place of search | Date of completion of search | Examiner |
|---|---|---|
| The Hague | 14 February 91 | GROSEILLER PH.A. |

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